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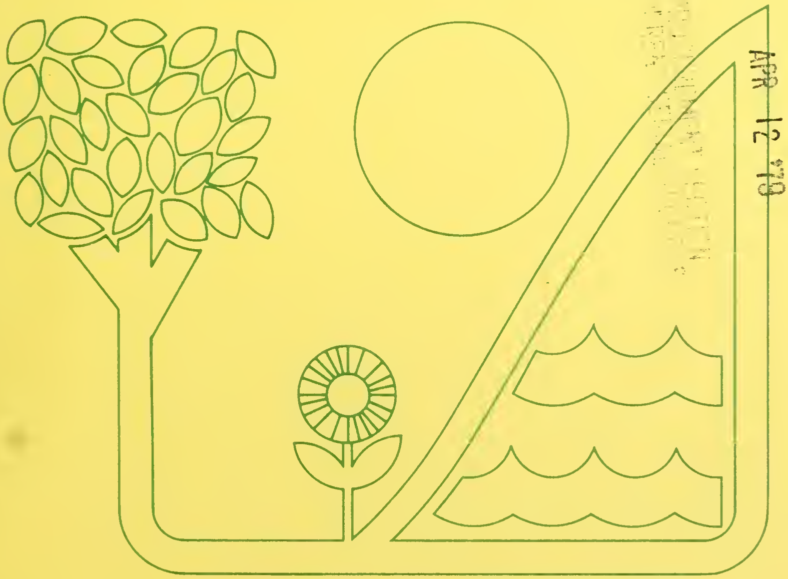

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LAND CLEARING IN EASTERN NORTH CAROLINA

CHOWAN-PASQUOTANK RIVER BASINS STUDY

by

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U.S. DEPARTMENT OF AGRICULTURE

Soil Conservation Service
Economics, Statistics and Cooperatives Service
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Northeastern Resources Group
Natural Resources Economics Division
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Abstract

Recent land clearing in Eastern North Carolina is identified through a computer based map overlay process. Land use changes are recorded for soil groupings built from the 1967 Conservation Needs Inventory. At the same time, this map overlay technique locates specific forest habitats that are likely to be affected by land use change in the future, while also indicating the extent of future agricultural potential.

Key Words: Overlay, Transition, Habitat, Productivity, Conversion, Clearing

Preface

This paper primarily analyzes the physical characteristics of specific areas within the Coastal Plain of North Carolina where land is rapidly being cleared. Potentials for land clearing are described in broad land use categories, such as forest to cropland. More detailed discussion of commodity production throughout the study area will be provided in a report entitled, "Projections of Land Use and Soil Loss in the Chowan-Pasquotank River Basin." Information in these two reports constitute a major part of the baseline projections against which alternative plans to achieve development and environmental goals are compared.

Land clearing on the Virginia portions of the Chowan River Basin is discussed only briefly in this report because clearing is proceeding much more rapidly in North Carolina. Although considerable areas physically suitable for drainage are identified in Virginia, these lands have been designated for natural uses and are administered largely by the U. S. Fish and Wildlife Service.

Updating of cropland availability and land use projections makes extensive use of the publication, "Soil Productivity Groups of North Carolina." Both agencies that worked on that publication provided helpful assistance in the use of various soils information and in reviewing parts of the present manuscript. Individuals who assisted include John Parks of the Economics, Statistics, and Cooperatives Service of the USDA and Robert Byrd and Bob Horton who are, respectively, the North Carolina State Soil Scientist and his assistant. Richard Googins, the Virginia State Soil Scientist, extended the Soil Productivity Groups into the Virginia portion of the study area.

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Introduction

Land use changes are occurring rapidly on the vast wetland areas of North Carolina's Coastal Plains. The swift and highly visible nature of the changes and the importance of land clearing from a national food production standpoint make it essential to attempt to record and anticipate the extent and physical nature of the transformations. Such information is also needed for assessment of indirect effects of clearing, including a substantial local economic stimulus, as well as impacts on forest resources, natural areas, water quality, and wildlife habitat.

Soil Productivity Groups, which are aggregated according to their potential productivity after drainage and clearing, provide the basis for anticipating change.[1/] In addition, detailed U.S. Geological Survey Land Use and Land Cover Maps are overlaid on computer based soils data to indicate the location of recent clearing and the kinds of soils which are affected by change. While indicating the magnitude of the remaining potential for creating cropland, map overlays also offer some broad insight into the kinds of forest and wetlands which are most likely to be affected.

Previous to this study, the best information concerning soil and land use relationships were the Soil Productivity Group (SPG) aggregations developed from the 1967 Conservation Needs Inventory. Since SPG's have not been mapped, it is first necessary to locate the geographic coordinates of the study area's Primary Sampling Units (PSU's) from the Conservation

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[1/] See (USDA, 1975) for a presentation of Soil Productivity Groups of North Carolina.

Needs Inventory. These coordinates are then assigned to the predominant soil group contained within each of the 160-acre PSU's. Computer soils maps are then generated through computer programs that will be described in the text, and they are fitted to USGS map overlays of 1974 land uses. Land use by SPG for 1974 is thus obtained by updating land use information for each Primary Sampling Unit. The SPG acreages for 1967 are compared with those obtained from the 1974 USGS overlays of computer maps.

It is then possible to summarize the acreages of specific land types that remain available for future cropland clearing. Hypotheses are tested about which areas are most subject to change.

Recent Experience With Clearing

Ditch drainage of land for farming is not a recent invention in Eastern North Carolina. In fact, early drainage operations date back to plantation agriculture near historic Phelps Lake, where channels dug by slave labor are still in use today.

Nevertheless, until the last ten years the trend in most of Eastern North Carolina was a reversion of farm land back into forest uses. The rapid clearing of new land has been a very recent innovation in North Carolina and has only barely begun in Virginia.

The Timing of Land Use Changes. Higher farm prices and improved biological technology in raising soybeans and corn throughout the South has reduced the previous trend toward land abandonment, and has given added incentive to large clearing operations. The rather dramatic relationship between farm prices and cropland acreage in several Piedmont and Coastal Plain counties of North Carolina is demonstrated in Figure 1. Increasing commodity prices since 1964 have reversed a rapid abandonment of piedmont land and speeded land clearing in the bottom lands.1/

Location of Land Use Changes. Figure 2 indicates the location of recent cropland increases in North Carolina. However, of the counties experiencing large gains in total cropland between 1969 and 1974, only Washington and Scotland Counties clearly accomplished those increases through additions to land in farms. Other large increases in cropland appear to represent

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1/ This graph is based on counties with high net gains in total cropland during 1969-74. Piedmont counties include Union, Stanly, and Anson. The Coastal Plain curve represents Washington, Tyrrell, Currituck, Gates, and Perquimans Counties.

Figure 1. Response of Cropland to Changes in Farm Prices

North Carolina
1954-1974

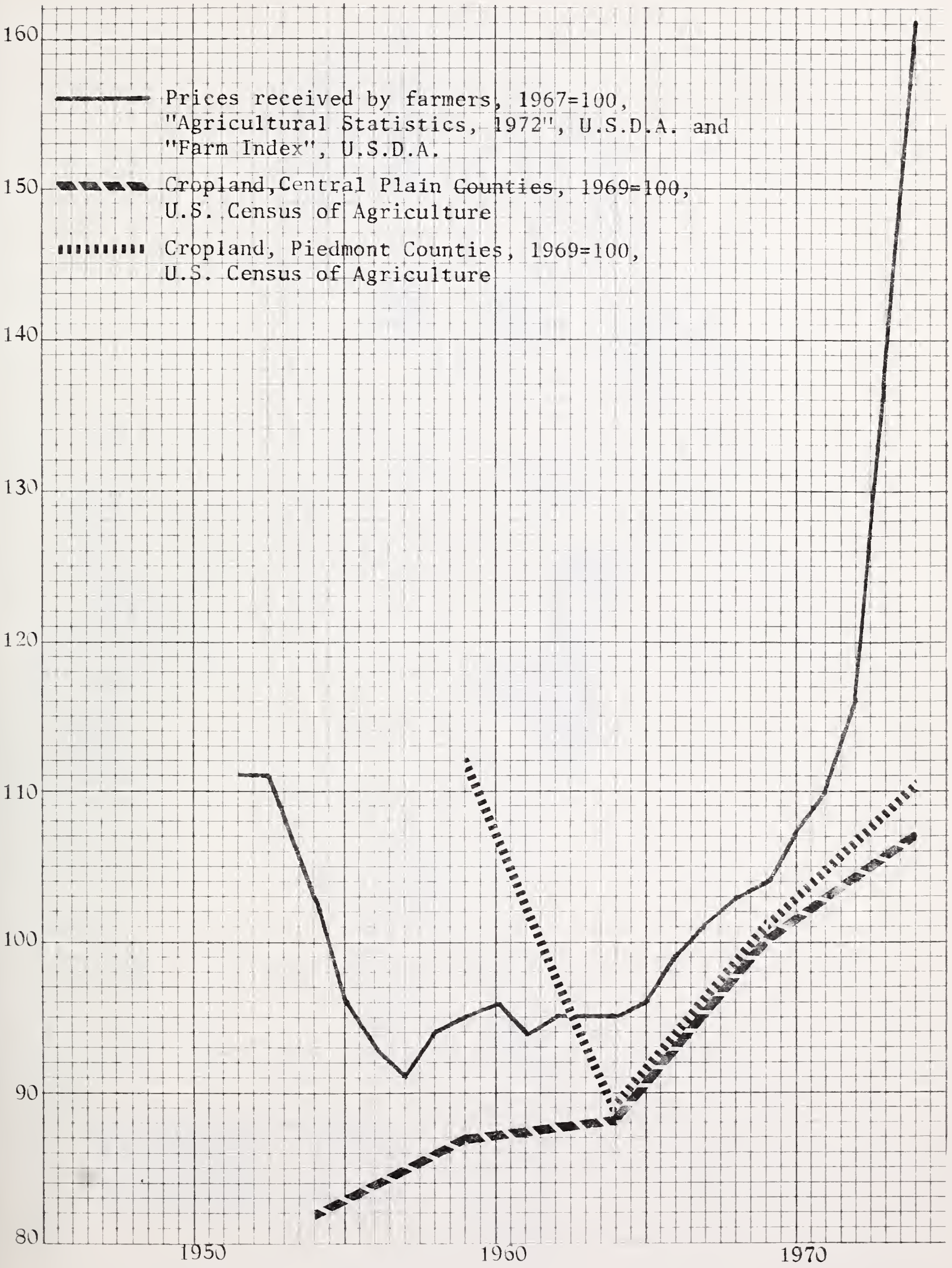
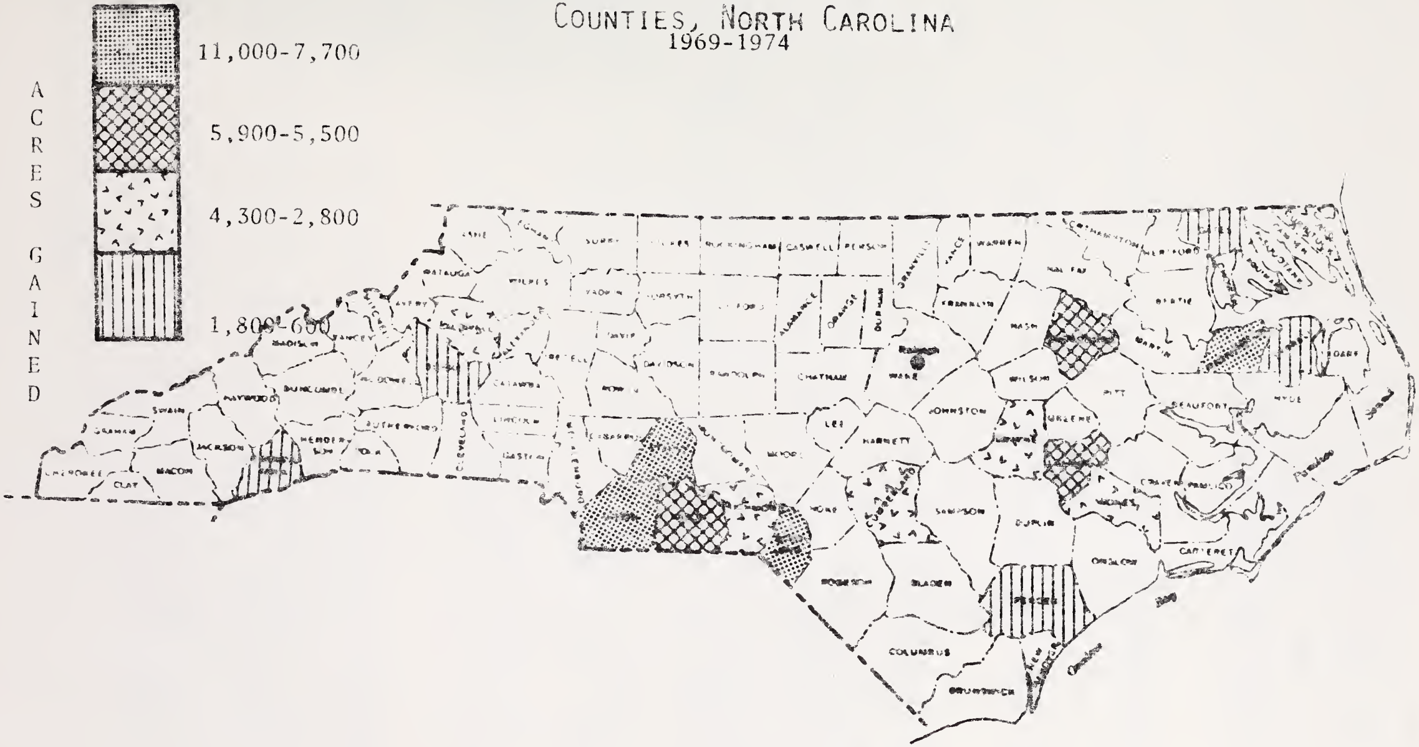


Figure 2

GAINS IN TOTAL CROPLAND
COUNTIES, NORTH CAROLINA
1969-1974



shifts from other farm land uses. In Union County, which experienced the largest gains outside the Coastal Plain, 27,619 acres of cropland were lost from 1959 to 1964, while 27,017 acres were added to other farm land. The 19,660 acres of cropland added in Union County from 1964 to 1974 evidently were shifted back into production from other farm uses and thus were not newly cleared.

Gains in cropland in the Coastal Plain, on the other hand, were primarily from newly cleared land. Washington County lost only 4,977 acres of cropland from 1959 to 1964, but gained 26,983 acres from 1964 to 1974, 22,575 acres of which were additions to land in farms.

Other Factors Affecting Change. Although the techniques for clearing and draining land do not appear to be new or complicated, the dramatic increase in the rate of clearing seems to suggest recent innovations as well as favorable economic conditions. Also, the tremendous size of most farm operations, with the area's largest farmer owning over 350 thousand acres, suggests size-related technologies that may account for part of the rapid acceleration in clearing operations. Tax incentives for corporate investment in land improvement contribute to land clearing activity, and financial economies of scale have affected the tremendous scale of typical clearing operations.

Regardless of what has been the primary cause of the sudden surge in land transformation, there is no established trend to indicate what will happen next. Assuming no public intervention, future changes will be affected by markets for farm products, by the success of recent operations, returns to competing forestry uses, and especially by the availability of additional land suitable for clearing.

Identification of Soils Suitable for Farm Use

The Conservation Needs Inventory (CNI) provides the most detailed source of information concerning the uses of the nation's soils in 1967, the appropriate uses to which those soils may be put, and the kinds of treatment needs required for farm uses. It is a powerful source of data for the planner, and especially useful for this project.

The CNI is based upon rather detailed sampling of the nation's soils. All rural non-federal land was included in the inventory. A stratified, non-aligned random field sample amounting to 2% of the actual land area was the basis of the CNI land classification and soil identification in most parts of the country. This classification system permits the definition of relationships between physical soil properties, soil productivity, and land treatment needs. In the absence of detailed soils maps, the CNI is the best available source of information about soil suitability for farm uses.

Systematic grouping of similar soils is required in order to anticipate change for hundreds of surveyed soils and thousands of soil subclasses. This task was greatly facilitated by "Soil Productivity Groups of North Carolina," a joint effort of John Parks of the Economic Research Service and soil scientists of the Soil Conservation Service. That study grouped hundreds of soils and their CNI subclasses into 32 groups, each having similar yields and treatment needs. These Soil Productivity Groups (SPG) were also roughly located on Soil Association maps of North Carolina, although the authors emphasized that SPG's are more precise in their composition of soils than can be located on a generalized soil map.

The problem of identifying mapped areas suitable for clearing is less

demanding of detail than was the case for the SPG "mapping" because the SPG groupings were designed for a number of treatment and land use concerns. Several of the eighteen principal SPG's in the coastal plain are, in fact, virtually identical in their economic potential for drainage and clearing.

Table 1 divides 16 counties of Eastern North Carolina into six groupings of soils, based upon combinations of the 18 original SPG's which dominate the Basin.[1] Virtually all of the Basin's rural land area is placed into these six groups through SPG aggregations of the CNI tape. Relationships to soil association maps are indicated very roughly.

According to Figure 3, two soil groups have large areas in both the Virginia and North Carolina portions of the Chowan-Pasquotank River Basin which are suitable for clearing: these are the shallow organic or muck soils and the productive, poorly drained soils (also shown in county detail in columns 2 and 3 of Table B1 in Appendix B.) The organic soils are listed separately from the other wet soil group that is being cleared. Also, organic soils may burn and thus have fire control problems which make them less suitable for competing forest industry uses.

Table 2 presents the yields for each SPG under typical management conditions. It is interesting to note that in some counties many of the sandy soils (column 6 of Table 1) have larger proportions of land in production than some of the more productive SPG's. The more productive, well-drained to moderately well-drained SPG's are, however, the most intensively farmed, as would be expected. Presumably, even a higher proportion of the

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1/ Since the map overlays are only used in the rapid change areas, which are in North Carolina, Virginia land uses are displayed only in Figure 3.

	Organic deep muck Soils (SPG 32)	Shallower organic Soils (SPG 31)	Productive soils, moderately well to very poorly drained (SPG 23, 26, 27)	Flood plain soils, Poorly drained (SPG 24)	Well drained to moderate poorly drained soils (SPG 18, 19,20, 22, 23 & some below 18)	Poor sandy soils, Misc. (SPG 21,25,28,29, 30,38)
Northampton			Craven-Leaf-Lenoir(5)	Bibb(4) Wehadkee-Chewacla-Congaree(7)	Norfolk-Wagram-Rains-Bibb(3) Cecil-Appling-Worsham(1) Faceville-Orangeburg-Bibb(2) Wickham-Roanoke-Altavista-Molena(6)	
Bertie	Dare-Pungo-Ponzer (7)		Lenoir-Coxville(5)	Roanoke-Chewacla-Wehadkee(6)	Norfolk-Duplin-Goldsboro (1) Lenoir-Craven-Dunbar(2) Wickham-Altavista-Wahee(3)	
Hertford	Dorovan-Dare-Johnston (6)		Lenoir-Coxville-Craven(3)	Roanoke-Cape Fear (5)	Norfolk-Goldsboro-Lynchburg(1) Craven-Duplin-Marlboro(2) Kalmia-Wagram(4)	
Gates	Ponzer-Dorovan-Dare (7)		Plummer-Torhunta-Portsmouth (3) Coxville-Myatt-Rains(5)	Johnston-Bibb(6)	Wagram-Norfolk-Goldsboro(1) Lenoir-Craven-Dunbar(2)	Lakeland-Chipley Pactolus(4)
Chowan	Dorovan-Johnston(6)	Dare-Ponzer-Wasda(7)	Bladen-Lenoir-Craven(2) Bladen-Bayboro-Portsmouth(3) Bertie-Tomotley-Altavista(4)		Conetoe-Wando-Dragston(1) Wickham-Altavista-Wahee(5)	
Perquimans	Dorovan-Johnston(6) Dare-Ponzer-Wasda (7)		Bladen-Lenoir-Craven(2) Bladen-Bayboro-Portsmouth(3) Bertie-Tomotley-Altavista(4)		Conetoe-Wando-Dragston(1) Wickham-Altavista-Wahee(5)	
Pasquotank	Peat-Swamp(7)		Pocomoke-Portsmouth(4) Bayboro(5) Pasquotank-Weeksville(1)		Bertie-Othello(2)	Elkton-Bladen(6) Othello-Bertie-Dragston(3)
Camden		Ponzer-Pamlico(5)	Pasquotank-Myatt-Barclay(1) Bayboro-Bladen(4)		Dragston-Bertie-Kalmia(2) Nahunta-Exum(3)	
Currituck		Ponzer-Pamlico(4)	Myatt-Coxville-Pasquotank(2) Blayden-Bayboro-Hyde(3)		Wagram-Ocilla-Dragston(1)	Capers(5) Newham(6)
Washington	Dare-Dorovan-Pungo (6)	Ponzer-Belhaven-Wasda(7)	Blayden-Myatt-Lenoir(4) Bayboro-Hyde-Bladen(5)		Kalma-Norfolk-Pactolus(1) Craven-Dunbar-Aycock(2)	
Tyrell	Belhaven-Dare-Dorovan(6)		Bertie-Lumbee-Johns(1) Myatt-Coxville(2) Hyde-Bayboro(3) Torhunta-Portsmouth(4) Pasquotank-Weeksville(5)			
Hyde	Dare-Pungo-Dorovan (5)	Ponzer-Belhaven-Wasda (6)	Myatt-Bladen(1) Weeksville-Pasquotank(2) Hyde-Bayboro(3)			Caspers-Newhan(4)
Dare	Dare-Pungo-Ponzer (3)	Wasda-Bladen(4)				Pactolus-Wakula-Wagram(1) Newham-Corella-Duck(2) Caspers(5)
Martin			Lenair-Craven-Bladen(3) Bladen-Portsmouth-Bayboro(4) Coxville-Rains-Lynchburg(5)	Wehadkee-Chewacla-Roanoke(8) Johnston-Bibb(6)	Goldsboro-Norfolk-Lynchburg(1) Duplin-Dunbar-Craven(2)	Wagram-Kenansville Lakeland (7)
Pitt			Lynchburg-Rains-Goldsboro(3) Lenoir Bladen-Craven(4) Coxville-Exum(5) Bladen-Byars(2)	Bibb-Portsmouth(6)	Norfolk-Exum-Goldsboro(1)	Roanoke-Lakeland-Altavista(2)
Beaufort	Muck(6) Swamp(7)		Lynchburg-Goldsboro-Dunbar(2) Coxville-Rains-Othello(3) Lenoir-Craven-Bladen(4)			Lakeland-Chipley (1)

FIGURE 5 CROPLAND AND FOREST LAND USE BY SUBREGION AND SPG AGGREGATION, 1967

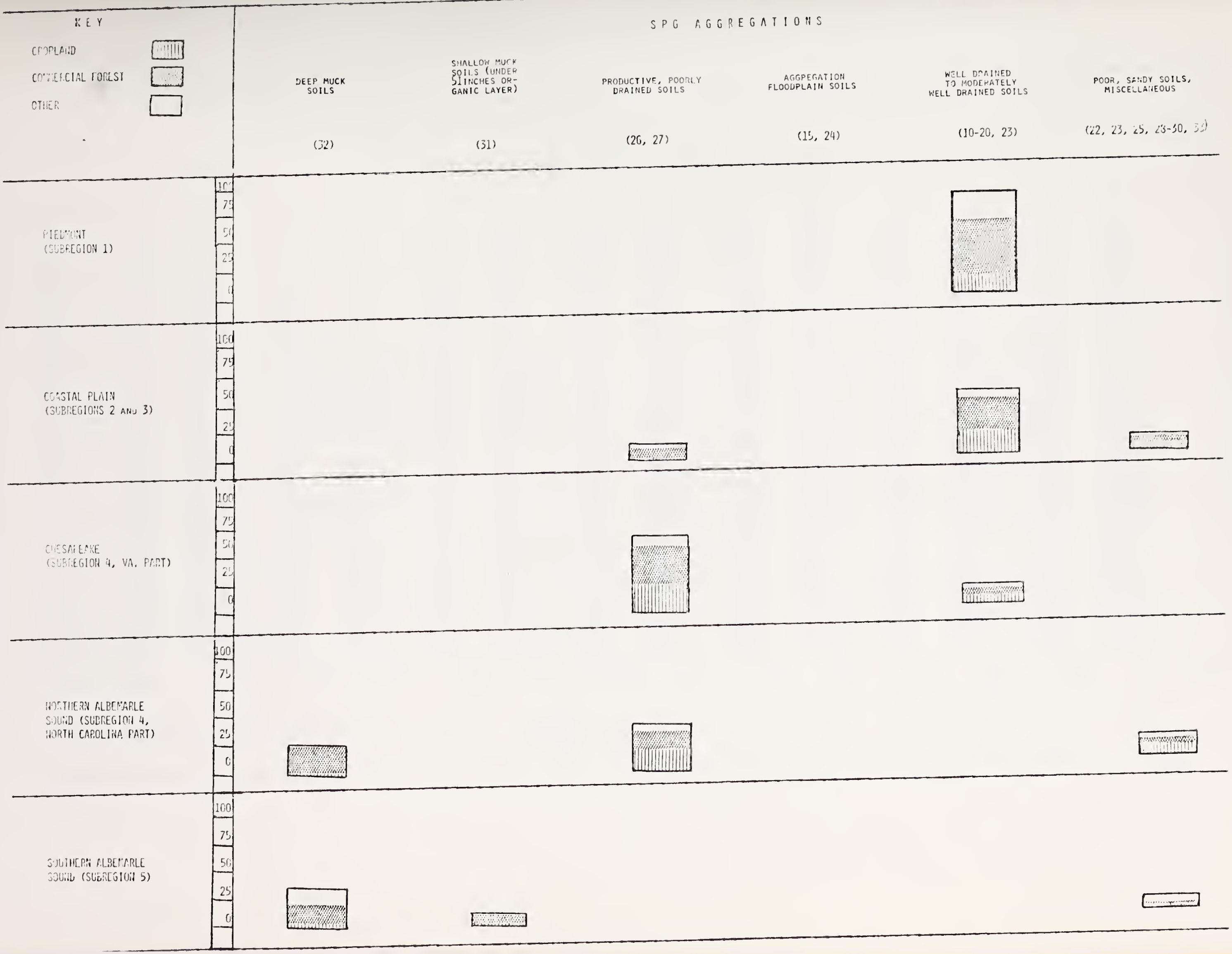

TABLE 2: Normalized Yields for Crops and Pasture by Soil Productivity Group for North Carolina—1970

	CORN GRAIN	CORN SILAGE	SORGHM GRAIN	SORGHM SILAGE	WHEAT	OATS	BARLEY	COTTON 1/	SWEET POTATOES	SOY-BEANS	PEANUTS	FLUE TOBACCO	BURLEY TOBACCO	IMP PASTURE	UNIMP PASTURE	ALL HAY
UNITS/ACRE	BU.	TONS	BU.	TONS	BU.	BU.	BU.	BALES	CWT.	BU.	LBS.	LBS.	LBS.	AUM	AUM	TONS
SPG 1	65.9	13.9	0.0	0.0	44.4	49.5	0.0	0.0	0.0	0.0	0.0	0.0	2485.2	6.9	2.2	1.4
SPG 2	54.7	11.2	0.0	0.0	34.7	38.5	0.0	0.0	0.0	0.0	0.0	0.0	2236.3	6.1	2.0	1.3
SPG 3	50.1	10.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1988.4	6.1	2.0	1.3
SPG 4	65.9	13.9	0.0	0.0	44.4	49.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	2.2	1.5
SPG 5	43.5	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	1.8	1.2
SPG 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	1.4	0.9
SPG 7	0.0 2/	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	1.5	1.0
SPG 8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	1.2	0.7
SPG 9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.6	0.4
SPG 10	62.6	13.4	55.2	12.4	44.4	65.5	50.4	0.8	0.0	22.3	0.0	1826.3	0.0	8.0	2.5	1.7
SPG 11	56.7	12.3	50.6	11.1	40.7	58.9	45.8	0.7	0.0	19.1	0.0	1775.5	0.0	6.9	2.2	1.4
SPG 12	43.5	9.6	46.0	8.9	37.0	47.3	41.2	0.6	0.0	15.9	0.0	1623.3	0.0	7.4	2.3	1.6
SPG 13	62.6	13.9	53.4	12.9	0.0	54.6	0.0	0.0	0.0	22.3	0.0	0.0	0.0	10.1	3.2	2.1
SPG 14	36.2	8.0	41.4	7.5	33.3	43.6	36.6	0.0	0.0	14.0	0.0	0.0	0.0	8.0	2.5	1.7
SPG 15	39.5	8.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.9	0.0	0.0	0.0	7.2	2.3	1.5
SPG 16	42.8	9.6	36.8	8.9	29.6	43.6	32.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	1.5	1.0
SPG 17	32.9	5.4	0.0	0.0	18.5	0.0	0.0	0.4	0.0	12.7	0.0	1724.8	0.0	5.0	1.6	1.0
SPG 18	72.5	15.0	59.8	13.7	44.4	65.5	54.9	0.8	158.4	28.0	2593.5	2384.3	0.0	10.7	3.4	2.3
SPG 19	49.4	10.2	46.0	0.0	33.3	43.6	0.0	0.7	140.8	19.1	2137.0	1927.7	0.0	9.5	3.1	2.0
SPG 20	74.4	12.3	59.8	11.1	44.4	61.8	54.9	0.7	0.0	25.5	2080.0	2130.6	0.0	10.1	3.2	2.1
SPG 21	42.8	11.8	0.0	0.0	33.3	43.6	41.2	0.6	123.2	19.1	0.0	1724.8	0.0	6.0	1.9	1.3
SPG 22	52.7	12.3	50.6	0.0	37.0	50.9	0.0	0.7	140.8	19.1	2297.1	2017.0	0.0	9.5	3.1	2.0
SPG 23	79.1	15.0	0.0	0.0	44.4	61.8	54.9	0.7	0.0	28.0	2000.7	2029.2	0.0	9.3	3.0	2.0
SPG 24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	2.2	1.5
SPG 25	42.8	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.9	1778.4	1519.9	0.0	6.0	1.9	1.3
SPG 26	69.2	14.5	0.0	0.0	40.7	58.2	0.0	0.6	0.0	26.7	0.0	0.0	0.0	8.0	2.5	1.7
SPG 27	72.5	12.3	0.0	0.0	40.7	58.2	0.0	0.0	0.0	28.7	0.0	0.0	0.0	9.2	3.0	1.9
SPG 28	36.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.7	0.0	0.0	0.0	6.0	1.9	1.3
SPG 29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	1.6	1.0
SPG 30	22.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	88.0	12.7	1482.0	1435.6	0.0	5.8	1.9	1.2
SPG 31	59.3	0.0	0.0	0.0	25.9	0.0	0.0	0.0	0.0	15.9	0.0	0.0	0.0	5.5	1.8	1.2
SPG 32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
STATE AVE.	63.0	13.3	53.4	12.1	39.5	51.4	49.7	0.7	145.5	22.4	2228.0	1973.0	2378.0	6.9	2.2	1.5

NOTE: Yields are to represent an average level of management centered on 1970 using state acres and yields for 1968 through 1972.

1/ 480 pounds net weight.

2/ A zero yield does not imply that crops are not grown on any of the soils in an SPG but that the acres of land devoted to a given crop are not of a consequence for consideration.

most productive soils would be farmed if they were not in favored locations for forestry uses.

The deep muck soils and the floodplain soils are the only poor ones which consistently have not been in crop production. It will become evident that today's clearing operations are much more selective than in the past, and that the vast majority of changes are occurring in SPG's 31, 26, and 27.

It should finally be noted that the deep muck soils of SPG 32 are going to be particularly relevant to both the environmental and the economic concerns of this study. These are wetland areas that are very expensive to clear. Since this muck contains over 30 percent woody material (including large logs) and since it may be over six feet deep, it is extremely expensive to bring into cultivation. Even when SPG 32 soils are drained and prepared for cultivation, it may take over 15 years of treatment to render the muck to a farmable soil consistency, and this is a risky process, even then. Fortunately for this study, SPG 32 is one of the least complicated to define and map in the main counties where it is found. Thus, identification of the extent and location of these wetlands is considered very relevant to defining the feasible limits for the rather dramatic changes in Eastern North Carolina's landscape.

Counties Susceptible to Change

Figure 4 maps the general location of soils most subject to change.[1/] The productive, poorly drained soils of SPG's 26 and 27 were in production to some degree in 1967 in all counties except Dare. The extent to which

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[1/] The procedure which generated Figure 4 is described in the following sections. Note that as a land mapping technique, no level of accuracy is claimed here; yet as a sampling technique, the CNI sample points are considered quite detailed.

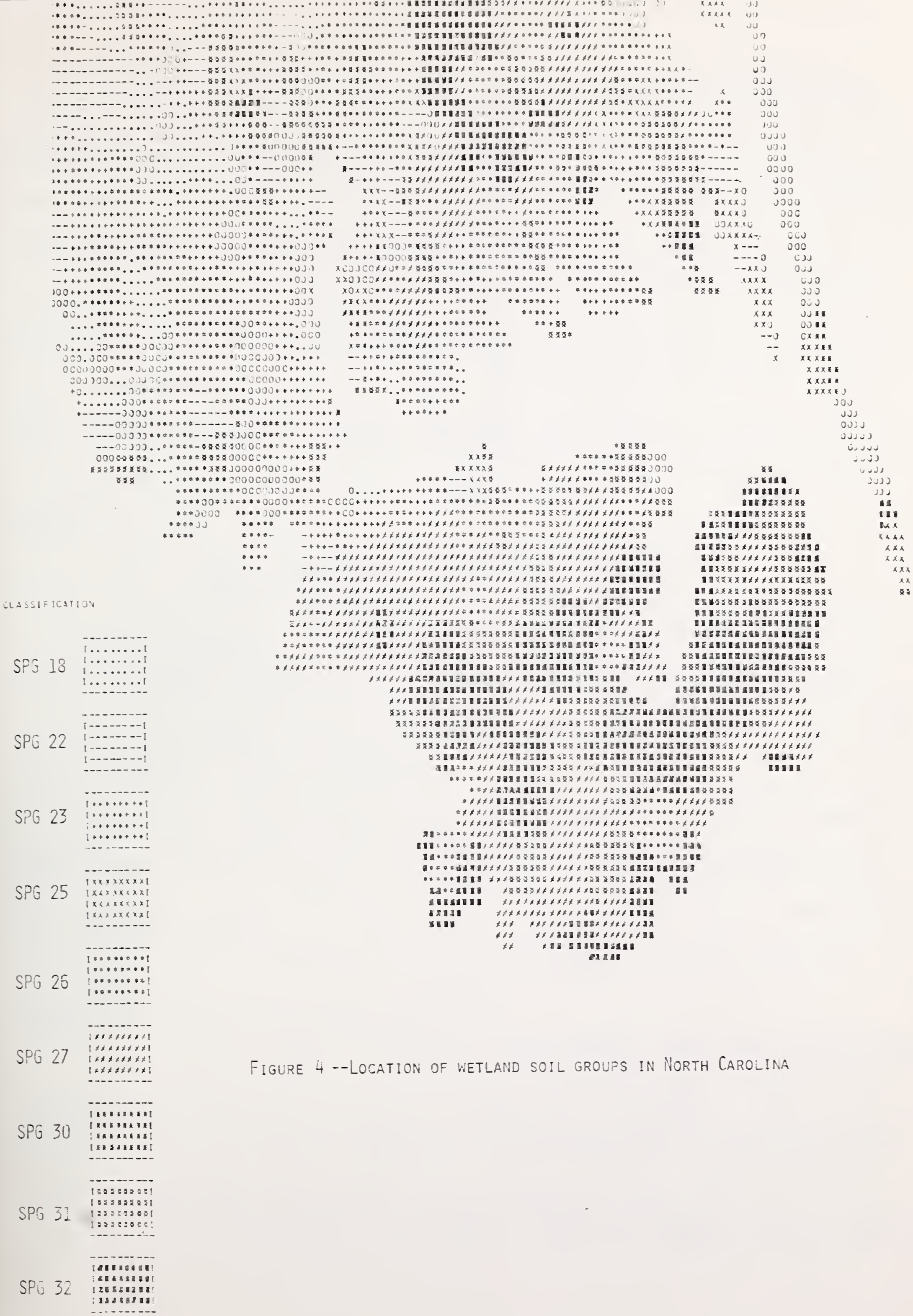

FIGURE 4 --LOCATION OF WETLAND SOIL GROUPS IN NORTH CAROLINA

drainage is feasible and the competition offered by forestry uses will determine how many more acres of these soils will be cleared for agricultural use. Shallow muck soils of SPG 31 are predominately located in the counties south of Albemarle Sound. Only Washington County had a substantial percentage of this soil in production in 1967, and this represented only about 1% of SPG 31 soils in Eastern North Carolina. Virtually all of the rest was held in commercial forest uses in 1967. The deep muck soils of SPG 32 are more widely distributed throughout the area, but are more in evidence south of the Sound. Agricultural use was made of this soil in 1967 only in Hyde County.

Recent Changes and Anticipating the Future

Success of future clearing operations is based upon detailed knowledge of soils and their suitability for farming. Failure by individual farmers to distinguish between the areas which have potentially productive soils might lead to extremely expensive mistakes.

Figure 3 has provided some indication of potentially drainable areas by indicating available acreages in the three SPG's which are believed to be most subject to change. In 1967 the percentage of these soils in commercial forests was a good indication of the land available. However, a lot of change has already taken place since 1967.

If the present analysis is correct, much clearing since 1967 should have concentrated on SPG's 26, 27, and 31 (Figure 4). Using maps of CNI Primary Sampling Units and 1975 U.S. Geological Survey Land Use and Land Cover maps, it will be possible to estimate land use changes between 1967 and 1974 for each SPG in the areas experiencing change. This will provide a test of the

hypothesis concerning soils affected by change; it will indicate which land types are affected by change; and it will show how much of various kinds of land remain as potential clearing sites.

However, it should be noted that this analysis is only appropriate for broad planning objectives. The absence of detailed soil maps and the approximate nature of the mapping techniques make them unsuitable for detailed planning.

Locating Sample Units. In order to overlay soil groups onto land use maps, it is necessary to determine SPG locations in space by sampling soils at frequent intervals. The CNI sample records, with their associated SPG's, provide this spatial dimension.

Location of these sample points had been designated by a 2-step process. First, the Statistical Laboratory at Ames, Iowa, located Primary Sample Units (PSU's) consisting of approximately 160 acres by randomly selecting these areas from strata superimposed on county base maps (SCS, Nov. 10, 1965). Second, individual state SCS personnel randomly oriented a sample grid on a detailed air photo/soil map of each PSU to obtain the individual sample points for which information was recorded (SCS, Nov. 3, 1965). Thus 10 to 50 points were sampled within each PSU.

Commensurate with the level of detail necessary in the data and in order to reduce the required effort, the 36,505 sample records within the Chowan Basin were aggregated to the PSU level by taking the major SPG, land use and treatment need, in terms of acreage represented. The method is outlined in Appendix A.

Using microfilm copies of the county base maps, the coordinates of each PSU were determined to the nearest half minute and were appended to the

aggregated CNI record for each PSU. The resulting data base consisted of 1,408 records, one for each PSU, with the dominant SPG, 1967 land use and 1967 treatment need, and geographic coordinates.

Mapping Sample Units. In order to graphically display the sample units, information on the aggregated PSU records was combined with data on county boundaries contained on the Census Bureau's Dual Independent Map Encoding County File (DIMECO).

The county boundaries of interest in the Chowan Basin were selected from the DIMECO file, which contains boundaries for all states and counties, using a utility program which examined each segment record and matched the state and county codes against a list of desired codes. The program and method are outlined in Appendix A.

Soil groups identified at their original sample points in each county provide a convenient update for the CNI land use data since these computer maps can be produced at the same scale as current land use maps.

Land Use Change on the Affected Soil Productivity Groups

Two sources of mapped information were used to update the 1967 information corresponding to these sample points. The United States Geological Survey publishes rectified 7.5 minute orthophoto quadrangle maps at a scale of 1:24,000 which display adequate shading and texture to distinguish between major land uses such as cropland and pasture, forest, and urban areas. In addition, for more limited areas, USGS has prepared Land Use and Land Cover maps from airphoto and satellite data at a scale of 1:250,000. (Anderson, et.al. 1976) These maps distinguish between 37 different land uses and cover types, shown in Table 3, and are thus more detailed and more accurate than the orthophoto maps. Orthophoto maps showing 1974 land use

Table 3. Land Use and Land Cover and Associated Maps

Land Use and Land Cover Maps	These maps show the following categories
LEVEL I	LEVEL II
1. Urban or Built-up Land	11. Residential
	12. Commercial and Services
	13. Industrial
	14. Transportation, Communications, and Utilities
	15. Industrial and Commercial Complexes
	16. Mixed Urban or Built-up Land
	17. Other Urban or Built-up Land
2. Agricultural Land	21. Cropland and Pasture
	22. Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas
	23. Confined Feeding Operations
	24. Other Agricultural Land
3. Rangeland	31. Herbaceous Rangeland
	32. Shrub and Brush Rangeland
	33. Mixed Rangeland
4. Forest Land	41. Deciduous Forest Land
	42. Exergreen Forest Land
	43. Mixed Forest Land
5. Water	51. Streams and Canals
	52. Lakes
	53. Reservoirs
	54. Bays and Estuaries
6. Wetland	61. Forested Wetland
	62. Nonforested Wetland
7. Barren Land	71. Dry Salt Flats
	72. Beaches
	73. Sandy Areas other than Beaches
	74. Bare Exposed Rock
	75. Strip Mines, Quarries, and Gravel Pits
	76. Transitional Areas
	77. Mixed Barren Land
8. Tundra	81. Shrub and Brush Tundra
	82. Herbaceous Tundra
	83. Bare Ground Tundra
	84. Wet Tundra
	85. Mixed Tundra
9. Perennial Snow or Ice	91. Perennial Snowfields
	92. Glaciers

Source: Anderson, et al. (1976)

were available for the entire region surrounding Albemarle Sound from the North Carolina Department of Natural and Economic Resources, as shown in Figure 5. Land Use and Land cover maps showing 1974 land use were obtained from USGS for Rocky Mount and Manteo quadrangles (Figure 5).

Land use change north of the Sound between 1967 and 1974 was assessed using the orthophoto quad maps by first superimposing a half minute grid over each quadrangle and locating each PSU by means of the coordinate on each aggregated PSU record. The 1974 land use was recorded as one of the four possibilities: 1) cropland and pasture; 2) forest land; 3) urban land; or 4) water. Each PSU record thus processed contained a land use observation for two points in time.

Since the Land Use and Land Cover maps were available as translucent overlays, a plot map of the county outlines and aggregated PSU data points was created at the same scale as the land use overlay and the 1974 land use read directly from the combined map.

The 1974 land use data from both sources was appended to the aggregated PSU records so that 1967 land use, 1974 land use, or the change in land use from 1967 to 1974 could be determined and mapped. A computer program was written to display land use changes by county and by soil productivity group. These data can be displayed in terms of the number of PSU's experiencing a particular change, or in terms of the acreage represented by sample points in each PSU experiencing the change.

New Cropland in North Carolina's Coastal Plain. The location of lands newly cleared for cropland supports hypotheses about where clearing takes place. Table 4 and Table 5 indicate that for both the counties north and those south of the Albemarle Sound, wetland soils are the ones experiencing rapid change. Specifically, SPG's 26 and 27 account for by far the largest portion of the new cropland acreage. SPG 31 is apparently less important, and it is being cleared more rapidly south of the Sound (largely by First Colony Farms),

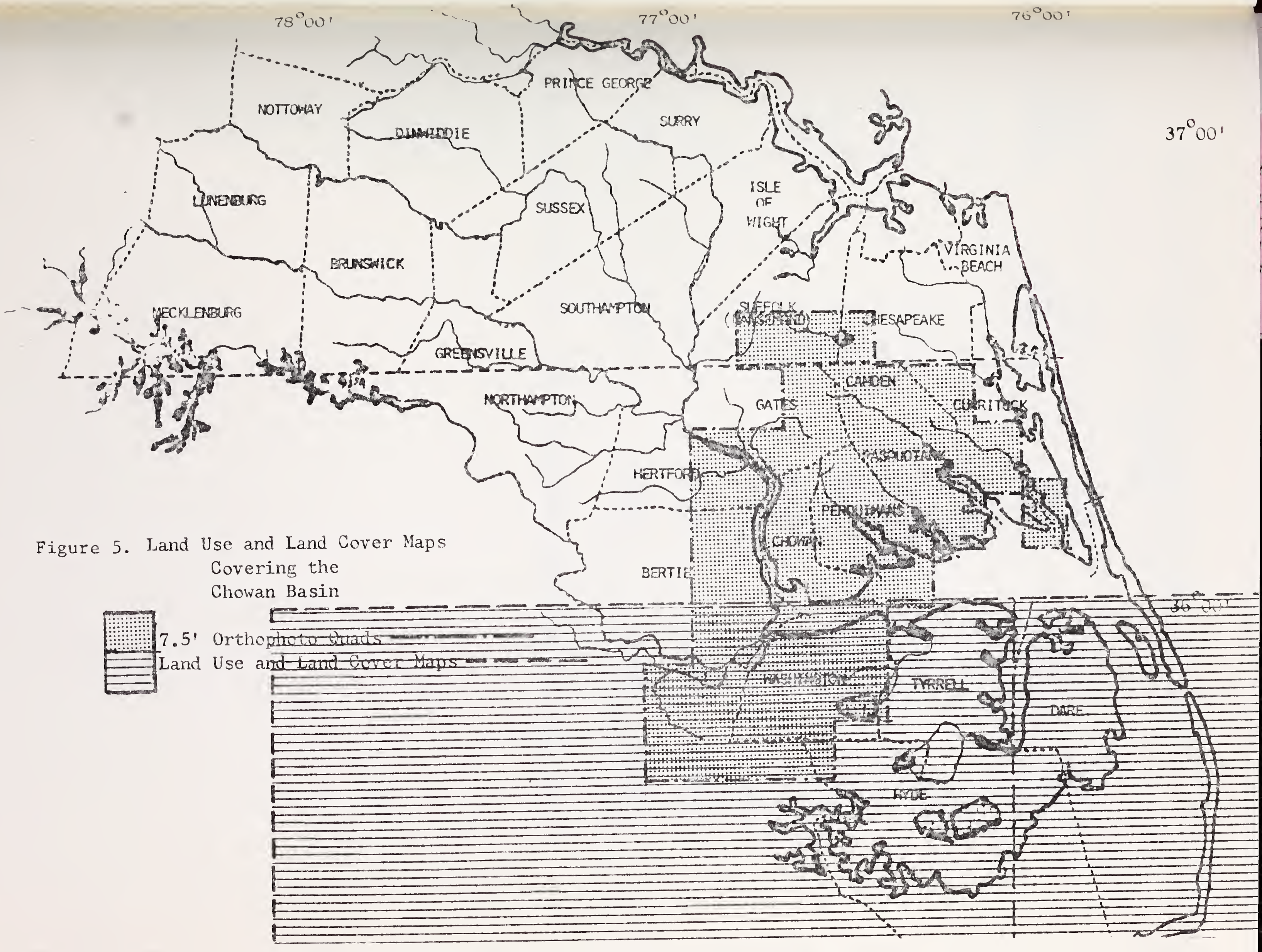

Figure 5. Land Use and Land Cover Maps Covering the Chowan Basin

Table 4. Soil Productivity Groups with Land Use Changes, Northern Albemarle Sound[1]
1967-1974

SPG	1967 Cropland & Pasture	+ New Cropland & Pasture Uses	- New Forest Uses	= 1974 Cropland & Pasture	1967-1974 Net Change
22	22,628	0	4,056	18,572	-4,056
23	60,303	23,340	18,423	65,220	4,917
25	38,518	28,304	11,248	55,574	17,056
26	133,476	39,720	22,521	150,675	17,199
27	23,891	24,833	6,724	42,000	18,109
31	0	1,292	0	1,292	1,292
32	107	11,005	0	11,112	11,005
TOTAL	278,923	128,494	62,972	344,445	65,522

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[1] Camden, Chowan, Currituck, Gates, Pasquotank, and Perquimans Counties.

Table 5. Soil Productivity Groups with Land Use Changes, Southern Albemarle Sound[1] 1967-1974

SPG	1967 Cropland & Pasture	+	New Cropland & Pasture Uses	-	New Forest Uses	=	1974 Cropland & Pasture	1967-1974 Net Change
23	11,631		2,417		6,558		7,490	-4,141
26	36,574		26,237		0		62,811	26,237
27	90,556		38,581		17,544		111,593	21,037
31	1,503		9,626		0		11,129	9,626
32	17,616		18,522		0		36,138	18,522
TOTAL	157,880		95,383		24,102		229,161	71,281

1/ Bertie, Dare, Hyde, Tyrrell, and Washington Counties.

rather than in the counties in Table 4. Although considerable activity is taking place on the highly productive SPG 23, forest uses continue to compete with agriculture on these remaining dry forest lands.

The new clearing on SPG 32 in both Tables appears to contradict the hypothesis that clearing activity will concentrate on the more productive soils. However, interviews with operators in the area have indicated that the firm responsible for clearing large areas of very poor land has gone out of business. Apparently, these lands are relatively easy to clear due to their naturally inhospitable nature with regard to growing plants. The problems come in removing wood and logs from the soil and in converting the soil to a farmable consistency. These latter problems were ignored by an operator who surely paid the price. (To some extent, society also bore certain costs, since much of this clearing took place close to historic Phelps Lake.) There is some reason, then, to expect future clearing activity to concentrate on the more productive soils.

Comparison of a county breakdown of these figures with a highly detailed 1974 forest survey for the forest acreage remaining in that year, is a test of the accuracy of the overlay technique (Table 6). The fact that Forest Survey figures tend to be slightly higher than these is probably largely due to its inclusion of forest acreage extending into urban boundaries. The similarity in results for two separate statistical surveys is a measure of the accuracy of the smaller sample.

Land Remaining in Forest Uses. For Basin Counties south of the Albemarle Sound Land Use and Land Cover maps provided detail for identifying how much of three types of forest land remains in each SPG. The forest habitat in Table 7 is divided into evergreen forest, mixed forest, and forested wetland. These account for the lands which may be affected by future

Table 6. Comparing Forest Estimates Against the 1974 Forest Survey (Minus CNI Non-Inventory Acreage)

County[1]	Updated CNI	Forest Survey Estimates Less Federal Non-Inventory Land[2]
Dare	133,290	134,381
Hyde	198,685	194,864
Tyrrell	207,707	213,411
Washington	110,904	114,012

[1] Only part of Bertie County was included in our study so it was excluded here.

[2] These Federal forest lands are omitted from the CNI sample used in this study. However, since a small portion of non-inventory urban lands are often forested, the figures in this column should be slightly greater than the updated CNI estimates, which they are. Apparently, forested urban acreages could account for most of the differences which remain (Welch and Knight, 1974).

Table 7. Forest Remaining
Southern Albemarle Sound[1/]
1967-74

Total 5 Counties	Evergreen Forest 42	ACRES Mixed Forest 43	Forested Wetland 61	Total
18	3,568.5			3,568.5
20			6,059.6	6,059.6
22	3,474.7		3,286.7	6,761.3
23		13,616.6	4,183.6	17,800.2
24			6,867.5	6,867.5
25			4,225.8	4,225.8
26	18,697.9	28,263.4	47,745.5	94,706.8
27	61,330.8	38,993.4	83,024.1	183,348.3
28			3,474.6	3,474.6
30			2,441.6	2,441.6
31	8,013.0	12,233.0	143,504.2	163,750.2
32	75,157.8	14,127.4	134,204.6	229,287.6
TOTAL	170,242.7	107,233.8	439,017.8	722,292.0

[1/] Bertie, Dare, Hyde, Tyrrell, and Washington Counties.

clearing.

Close to two-thirds of the forested wetland south of the Albemarle Sound falls in soil groups that may experience clearing activity, and this forest category accounts for 62% of land falling in SPG's 26, 27, and 31. Surprisingly, on a percentage basis, remaining evergreen forests are only slightly less able to claim future cropland potential than forested wetlands, with 52% in soil groups subject to change. Mixed forests have the largest proportion (72%) of their acreage in the three soil groups where clearing is expected to take place.

Table 8 provides an indication at the county level of how clearing potential is distributed within the sample area. Tyrrell County has the most land available for clearing, although it also has about a third of its forest on deep muck soils. Dare and Hyde Counties have the greatest potential for natural uses. Both claim substantial acreages of potentially productive shallow muck soils, but on the other hand, more than half of their forest is suited primarily for use as natural habitats, especially for bears, snakes, and birds. It apparently could be of some concern whether these acreages are sufficient to support the remaining black bear population of North Carolina's Coastal Plain.

Table 8. Forest Remaining,
Southern Albemarle Sound
1967-74

	Remaining 1974			
County and SPG	Evergreen Forest 42	Mixed Forest 43	Forested Wetland 61	Total
Bertie County (Part)				
20			6059.6	6059.6
23				
24			6867.5	6867.5
26		13533.1	25046.3	38579.4
31			20198.6	20198.6
County subtotal		13533.1	58172.0	71705.1
Dare County				
27	12816.4		6835.4	19651.8
31	6322.7		46822.5	53145.2
32	29221.4	6322.7	24949.2	60493.3
County subtotal	48360.5	6322.7	78607.1	133290.3
Hyde County				
26	7804.7	8250.7	8027.7	24083.1
27	7804.7		24083.1	31887.8
31		8250.7	32110.8	40361.5
32	45936.4	7804.7	42814.5	102353.4
County subtotal	61545.8	24306.1	107036.1	198685.8
Tyrrell County				
23			2305.5	2305.5
26			14671.5	14671.5
27	23055.2	14671.5	45062.5	82789.2
31		3982.3	37517.1	41499.4
32			66440.9	66440.9
County subtotal	23055.2	18653.8	165997.5	207706.5
Washington County				
18	3568.5			3568.5
22	3474.7		3286.7	6761.3
23		13616.6	1878.1	15494.7
25			4225.8	4225.8
26	10893.2	6479.6		17372.8
27	17654.5	24321.9	7043.1	49019.5
28			3474.6	3474.6
30			2441.6	2441.6
31	1690.3		6855.2	8545.5
32				
County subtotal	37281.1	44418.1	29205.1	110904.3

Conclusions

Although predicting the future location of agricultural activity is a difficult task, there are strong indications that Eastern North Carolina is going to play an expanding role in meeting future increases in United States and world food demands.

While the job of projecting future crop increases is left to a separate publication, the present effort locates areas likely to be affected by change. This is based upon aggregations of computer based soils information. Recent clearing activity was first analyzed, and results strongly supported hypothesis about which soils are affected by change. For the southern portion of the area affected by change, it was possible to identify the specific forest habitats most affected in each county.

Whether areas with potential for agricultural uses are actually cleared and brought into production depends on whether national and world demands continue to expand as expected. Also, since large scale clearing is a fairly recent phenomenon, the area's competitive advantage is not yet firmly established. Recent moves to sell First Colony Farms, the largest local firm, casts some doubt on future clearing potential. However, commodity price trends are now very much in doubt, so recent activity during high price years suggests a possibility of dramatic changes in the future.

Another publication will shortly consider in more detail potential crop output increases under a consistent set of national demand figures. Those projections will make use of the soil-land use relationships established here.

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APPENDIX A

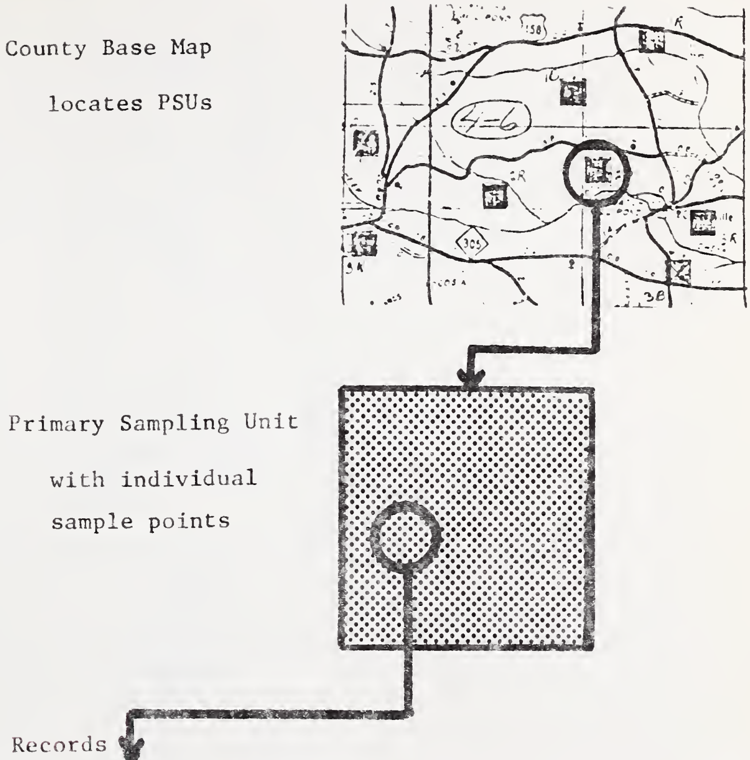
Locating Sample Units. In order to map information contained in the CNI sample records, they must be aggregated to larger units representing areas for which location can be determined. Each state CNI computer tape consists of a 24 field record for each point sampled, identifying the point and its soil, slope and land use characteristics. The program CNIMATCH aggregates individual sample records into a single record for each Primary Sampling Unit (PSU), records the geographic coordinates of the PSU obtained from county base maps, and records the 1974 land use obtained from USGS Land Use and Land Cover Maps. The process is illustrated in Figure A1.

Mapping Sample Units. The segment file structure of DIMECO was converted into a different file structure in which "chains" of segments making up entire polygons were strung together from the individual boundary segments. This is an important step in that most mapping program packages, such as SYMAP and CALFORM, use a form of this chain file structure in their input data. Conversion of the Basin boundary file was accomplished using POLYVRT, a program package produced by the Harvard Laboratory for Computer Graphics and Spatial Analysis. (Laboratory for Computer Graphics, 1974).

Two kinds of graphical display can be produced from the data contained in the aggregated PSU records and in the Basin boundary file as shown in Figure A2: 1) plotter maps showing the boundary of counties in the basin and the location and identity of each PSU; and 2) printer maps showing shaded zones based on the PSU's. The programs which accomplish this mapping are briefly described below.

Plotter mapping is the simpler of the two forms, and is accomplished

Figure A1
Processing Primary Sample Unit (PSU) Records



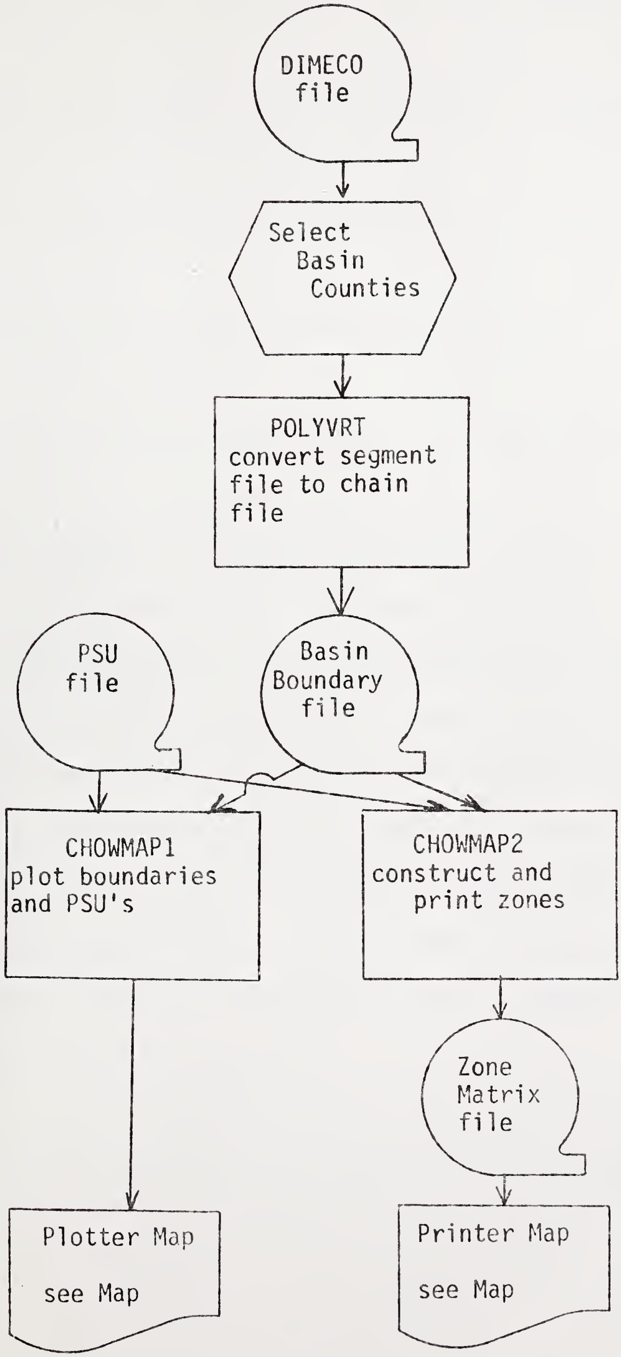
Individual Sample Records

```
33008768050201R31133 P14021200    13            20043- - 000 3W1   F14-00201986   *CHEWACLA S
33008768050201R31133 P14021200    13            19043- - 000 3W1   F14-00201986   *CHEWACLA S
33008768050201R31133 P14021200    13            18043- - 000 3W1   F14-00201986   *CHEWACLA S
33008768050201R31133 P14021200    13            17014- - 000 2W1   F14-00201986   *CONGAREE S
33008768050201R31133 P14021200    13            16043- - 000 3W1   F14-00201986   *CHEWACLA S
33008768050201R31133 P14021200    13            15043- - 000 3W1   F14-00201986   *CHEWACLA S
```

Aggregated PSU Record

```
33008020402R 153 T14021200 07271496 26 944 F1000 F-1000 35525 77010
33008020501R 153 T14021200 07473482 20 432 L 729 L2 486 35535 76575
33008020503R 153 T14021200 06867524 261000 F1000 F-1000 35505 76535
33008020601R 153 T14021200 06463552 261000 F1000 F-1000 35550 76465
```

Figure A2
Mapping of Sample Units



by a program called CHOWMAP 1 which was written for this project by Tom Elwertowski of ESCS. The program scales the geographic coordinates of boundary points and data points, converts them to a Cartesian coordinate system used by the plotter, limits the plot to a "window" specified by control cards through a process called "clipping," and controls the movements of the plotter pen to draw the county boundaries and indicate the location and identification of each data point. Data points consist of the PSU's, which can be identified by the associated SPG, land use, or treatment need, or by any other identification field in the aggregated PSU record.

Printer mapping is more complex. A program called CHOWMAP 2, which draws on elements of many existing mapping packages, was written to accomplish this mapping. The program works with a matrix consisting of one cell for each print position within the frame of the map. Each PSU identification is associated with the cell representing its location in the matrix. Every other cell in the matrix is assigned a PSU identification corresponding to the nearest PSU. Any value, such as SPG or land use, which is associated with the PSU identification can be mapped as a gray shading for that matrix cell. The resulting map is made of shaded areas representing known values shown in a key. Printer maps can be scaled to any size and shown for any "window" just as plotter maps. Figure 4 was produced in this way.

APPENDIX B.

Table B1 Cropland and Forest Land Use by County and SPG Aggregation, 1967

	Soil Productivity group					
North Carolina Counties	deep muck soils (32)	shallow muck soils (under 51 inches organic layer) (31)	productive, poorly drained soils (26,27)	aggregation floodplain soils (15,24)	well drained to moderately well drained soils (10-20, 23)	poor, sandy soils, misc. (22,23,25, 28-30,33)
Bertie						
Acres	26,662	0	148,459	37,367	190,271	24,643
%cropland	0.0%	0.0%	3.1%	0.5%	38.5%	27.9%
%comm forest	99.2%	0.0%	73.4%	94.1%	43.5%	45.1%
Camden						
Acres	63,633	4,545	58,534	2,771	11,086	9,866
%cropland	0.0%	0.0%	27,5%	4.0%	65.0%	49.4%
%comm forest	99.5%	100.0%	67.8%	92.0%	27.0%	41.6%
Chowan						
Acres	9,908	0	37,608	3,842	26,285	32,755
%cropland	0.0%	0.0%	29.8%	0.0%	60.3%	52.3%
%comm forest	97.5%	0.0%	63.4%	100.0%	29.0%	38.9%
Currituck						
Acres	22,310	2,295	53,341	4,774	5,233	75,467
%cropland	0.0%	0.0%	42.7%	0.0%	63.2%	41.3%
%comm forest	95.1%	100.0%	47.3%	88.5%	26.3%	9.9%
Dare						
Acres	103,556	47,506	26,316	0	0	39,303
%cropland	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
%comm forest	30.7%	99.6%	100.0%	0.0%	0.0%	24.8%
Gates						
Acres	47,578	6,351	72,981	2,583	63,079	23,789
%cropland	0.0%	0.0%	16.1%	0.0%	39.9%	30.7%
%comm forest	100.0%	100.0%	81.6%	100.0%	53.9%	65.6%

Hertford						
Acres	8,486	0	52,159	9,391	116,084	35,
%cropland	0.0%	0.0%	3.3%	0.0%	34.5%	44.
%comm forest	98.7%	0.0%	93.5%	98.8%	56.9%	48.
Hyde						
Acres	148,736	24,083	136,025	0	1338	42,8
%cropland	11.8%	0.0%	41.2%	0.0%	16.7%	0.
%comm forest	88.0%	99.1%	53.3%	0.0%	83.3%	3.
Northamton						
Acres	9,037	0	46,805	22,012	179,339	73,
%cropland	0.0%	0.0%	4.0%	4.2%	45.2%	45.
%comm forest	100.0%	0.0%	95.0%	75.8%	47.4%	47.
Pasquotank						
Acres	54,550	0	63,584	1,258	13,495	7,
%cropland	0.0%	0.0%	68.0%	9.1%	53.4%	48.
%comm forest	99.8%	0.0%	22.8%	81.8%	36.4%	47.
Perquimans						
Acres	19,718	0	96,341	1,072	24,433	20,
%cropland	0.5%	0.0%	47.3%	10.0%	42.5%	38.
%comm forest	99.5%	0.0%	48.3%	79.9%	50.9%	54.
Tyrrell						
Acres	86,981	23,474	126,804	1,677	4,192	9,
%cropland	0.0%	0.0%	18.5%	0.0%	65.0%	7.
%comm forest	22.9%	100.0%	71.6%	100.0%	20.0%	30.
Washington						
Acres	15,495	3,287	134,098	4.977	23,195	24,
%cropland	0.0%	31.4%	30.7%	1.9%	53.8%	51.
%comm forest	17.0%	51.4%	59.7%	98.1%	34.4%	36.
North Carolina Subtotal						
Acres	616,648	111,542	1,053,055	91,724	658,026	421,4
%cropland	2.9%	.9%	26.5%	1.7%	42.4%	32.
%comm forest	72.2%	98.2%	68.0%	93.5%	48.4%	33.

Table B1 (continued)

Virginia Counties	deep muck soils (32)	shallow muck soils (31)	1/ productive, poorly drained soils (26,27)	aggregation floodplain soils (15,24)	well drained to moderately well drained soils (10-14,16-20,22,23)	poor, sandy soils, Misc. (21,25, 30,3
Brunswick						
Acres	0	0	0	23,851	329,670	472
%cropland	0.0%	00.0%	0.00%	6.9%	0.0%	0.00%
%comm forest	0.0%	00.0%	0.00%	89.1%	45.2%	50.00%
Cheasapeake						
Acres	1,170	1,170	147,971	12,867	24,564	15,498
% cropland	0.0%	0.0%	37.70%	11.4%	25.6%	189%
%comm forest	100%	100%	52.20%	88.6%	54.7%	62.3%
Dinwiddie						
Acres	0	0	5,999	23,327	267,936	6,887
%cropland	0.0%	0.0%	7.4%	1.0%	20.5%	6.4%
%comm forest	0.0%	0.0%	92.6%	7.6%	76.4%	93.5%
Greensville						
Acres	2,454	2,454	2,998	21,768	146,186	12,165
%cropland	0.0%	0.0%	0.0%	1.0%	26.30%	31.6%
%comm forest	100%	100%	100%	97.1%	66.60%	56.1%
Isle of Wight						
Acres	5,772	5,772	15,900	5,445	119,578	47,918
%cropland	0.0%	0.0%	11,0%	0.0%	51.4%	12.7%
%comm forest	96.2%	96.2%	82.2%	88.0%	41.0%	69.1%
Lunenburg						
Acres	0	0	0	14,258	265,339	
%cropland	0.0%	0.0%	0.0%	1.7%	17,4%	
%comm forest	0.0%	0.0%	0.0%	91.5%	70.6%	

Table B1(continued)

Virginia Counties	deep muck soils (32)	shallow muck soils (31)	productive, poorly drained soils (26,27)	aggregation floodplain soils (15,24)	well drained to moderately well drained soils (10-14,16-20,22.23)	poor, sandy soils, Misc. (21,25,2 30,3
Mecklenburg						
Acres	0	0	0	26,242	324,782	897
%cropland	0.0%	0.0%	0.00%	10.3%	25.3%	25.0%
%comm forest	0.0%	0.0%	0.00%	63.2%	55.9%	0.0%
Nansemond						
Acres	8,843	8,843	38,589	9,915	154,890	20,367
%cropland	0.0%	0.0%	6.9%	2.7%	47.6%	11.80%
%comm forest	100%	100%	93.1%	91.9%	46.5%	63.20%
Nattoway						
Acres	0	0	0	16,125	148,807	1,152
%cropland	0.0%	0.0%	0.0%	11.4%	27.9%	0.0%
%comm forest	0.0%	0.0%	0.0%	7.1%	7.7%	100%
Prince George						
Acres	3,528	3,528	2,822	4,469	140,872	11,759
%cropland	3.3%	3.3%	8.3%	0.0%	22.20%	6.0%
%comm forest	96.7%	96,7%	91.7%	100%	75.0%	60.0%
Southampton						
Acres	15,686	15,686	18,912	33,374	244,964	53,398
%cropland	0.7%	0.7%	14.1%	3.3%	37.6%	20.0%
%comm forest	98.6%	98.6%	85.9%	94.0%	54.6%	70.4%
Surry						
Acres	4,138	4,138	730	3,408	103,210	60,125
%cropland	0.0%	0.0%	33.3%	0.0%	35.8%	23.5
%comm forest	100%	100%	33.3%	100%	62.5%	67.2

Table B1 (continued)

Virginia Counties	deep muck soils (32)	shallow muck soils (31)	productive, poorly drained soils (26,27)	aggregation floodplain soils (15,24)	well drained to moderately well drained soils (10-14,16-20,22,23)	poor, sandy soils, Misc. (21,25,28-30,33)
Sussex						
Acres	7,172	7,172	4,635	35,752	216,940	38,843
%cropland	0.0%	0.0%	0.0%	0.6%	21.6%	15.9%
%comm forest	100%	100%	76.2%	95.7%	74.1%	71.0%
Virginia Beach						
Acres	3,245	3,245	77,274	309	34,618	14,527
%cropland	0.0%	0.0%	36.8%	0.0%	67.9%	57.5
%comm forest	85.7%	85,7%	44.8%	0.0%	14.3%	6.4%
Virginia Subtotal						
Acres	52,009	52,009	315,818	231,111	2,522,356	284,006
%cropland	0.4%	0.4%	29.3%	4.3%	26.80%	31.0%
%comm forest	98.0%	98.0%	60.8%	84.2%	64.10%	64.4%

1/ The Virginia CNI lacks detail concerning the division of soils between SPG 31 and 32. Based upon knowledge of the State Soil Scientist, muck soils are divided evenly between the two SPG's.